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NCEL Techdata Sheet

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Photovoltaic Array Tester

This Techdata Sheet is directed primarily to owners and operators of photovoltaic systems. It describes unique test equipment for solving field problems and obtaining lifetime performance data. This system enhances troubleshooting and data acquisition.

The U.S. Navy has approximately 100 photovoltaic (PV) systems installed around the world. These systems, varying in size from a few watts to 50 kW, are used to provide power for communications, test data acquisition, security lighting applications, etc. To provide in-field maintenance support for these PV systems, the Naval Civil Engineering Laboratory (NCEL) has developed diagnostic equipment called the PV Array Tester (Figure 1).

Figure 1. PV Array Tester.

OBJECTIVE

The NCEL PV Array Tester is now fully developed and available to solve field problems. The tester is not available commercially; its operation is documented in an NCEL handbook. The portable self-contained PV Array Tester allows on-site evaluation of PV system performance. The test equipment measures the current/voltage (I-V) response of any PV unit from 10 to 10,000 watts and the locus of points can be plotted by the accompanying X-Y recorder (Figure 2). Analysis of these I-V data is the most comprehensive method for defining the performance of the PV array. The data can also be used to identify and locate PV module failures within the array.

The PV Array Testers are presently used to obtain lifetime performance data on PV arrays as well as to check out new systems and troubleshoot existing systems.

PV Array Testers are maintained at NCEL and at the Energy Program Office, NWC, China Lake, Calif. The testers can be used to check out PV arrays at Navy facilities by making appropriate travel and funding arrangements with the NCEL contact identified below.

DESCRIPTION AND USE

The PV Array Tester is designed for easy operation, is rugged and can be operated at remote sites, and is self-contained and requires no external power source. The unit is packaged in a 21- by 13- by 7-inch suitcase and weighs 33 pounds. I-V data can be obtained and recorded manually or automatically if an X-Y recorder is available and interconnected with the tester. The tester has four current scales, 2.5, 10, 20, and 40 amperes, and four voltage scales, 25, 100,

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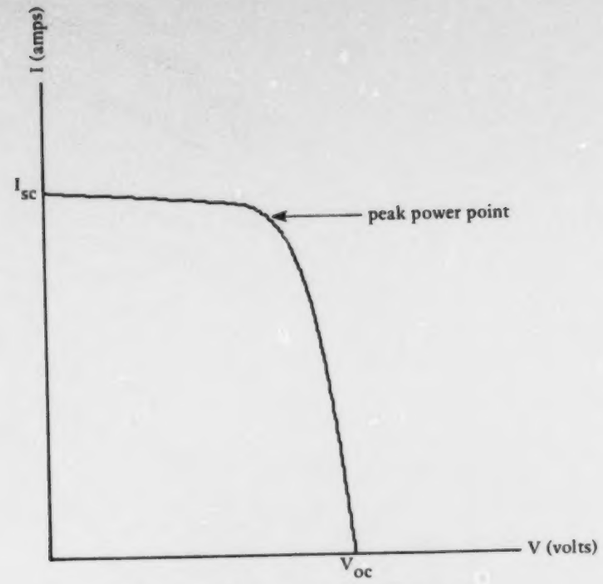

Figure 2. I-V curve for a normal PV module.

200, and 400 volts. Any combination of current and voltage scales can be selected depending on the PV array under test. After scale selection the tester is activated with a single push button "GO" switch. When the I-V curve is complete the tester will automatically stop. Multiple curves can be repeated on the same graph to allow relative comparisons to be made in the field. The data can later be normalized to standard operating conditions to determine the PV array rating or to compare performance between systems.

INTERPRETING I-V DATA

An I-V curve provides the most comprehensive set of data for checking out or diagnosing problems with an assembly of PV modules. An assembly of PV modules may be considered to be a single module or a set of modules connected in either series or parallel or both. While a PV Array Tester may not be necessary to check out a small PV array (10 modules or less), it is indispensable in checking out larger arrays. The comprehensive nature of the I-V curve is due to the fact that the PV assembly is loaded at all power producing conditions from zero to short-circuit and zero to open-circuit voltage. A PV system that is underperforming will produce an I-V curve with anomalies that reflect various problems associated with underperformance. Most problems will cause a lowering of the peak power point of the I-V curve. Examples of causes of a low peak power point are open-circuited cells, shorted by-pass diodes, and high-resistance connections. Another anomaly is a reduced short-circuit current, which is typically caused by short-circuited modules or open-blocking diodes. Once an anomaly in the I-V curve has been identified, the problem causing the loss of power production can be isolated with use of a digital voltmeter and a clamp-on ammeter using conventional circuit check out procedures.

NCEL CONTACT

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